Solar Cooker Insulation

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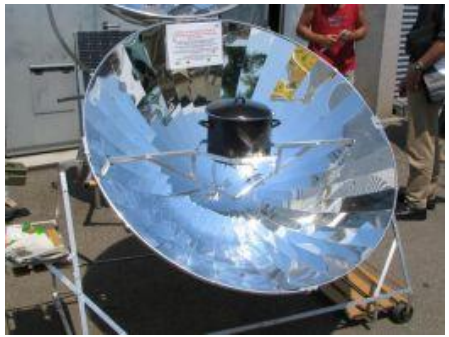
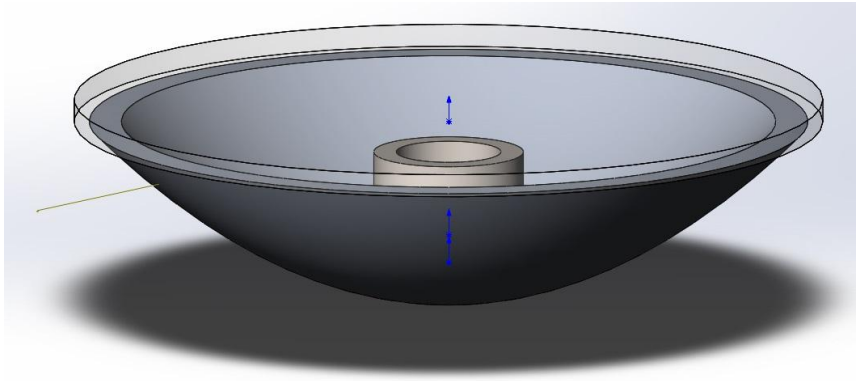


What kind of solar cooker insulation will give the best balance of price while boiling water the fastest?

- Four insulation materials: rubber, glass, cork, and wool
- For each material, tested multiple thicknesses--from 1-30 mm
- For each pair of insulation material & thickness, we evaluated the score
  - Normalized the range of costs
  - Normalized the range of the time to boiling
- Normalized score from 0 to 1: one being the best, 0 the worst.

$$score = \frac{1}{\frac{cost}{cmax} * \frac{t_{boil}}{tmax - t_{min}}}$$

Assumptions



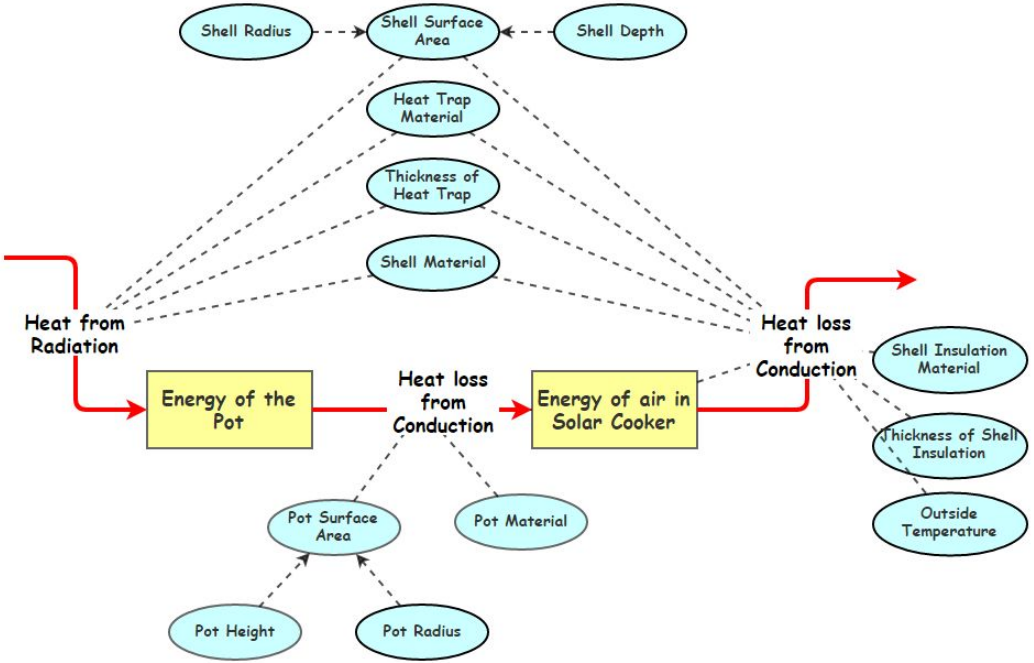
Idealized conditions

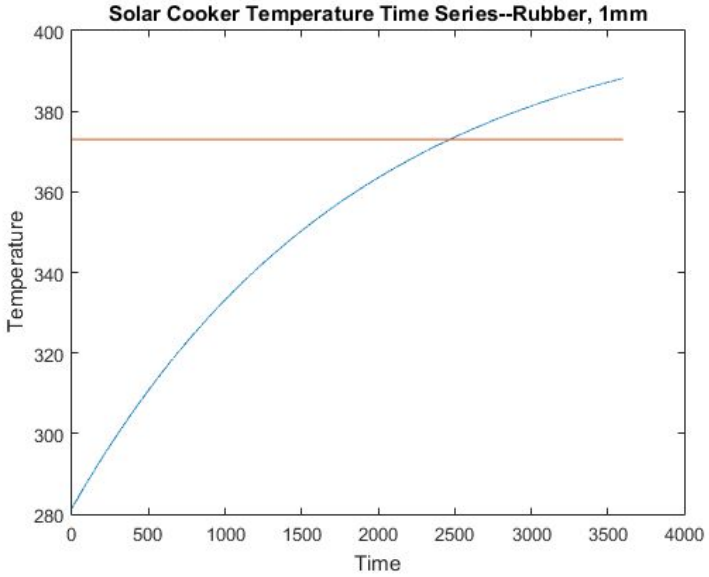
- Clear lid/heat trap that insulates all heat
- Air inside the solar cooker will not absorb radiation
- Perfectly reflective sheet of negligible thickness

Constant values

- Dimensions based on existing cooker
- The environmental variables taken as the annual average
- Pot is made of cast iron, and filled with water (initially the same temperature as outside air)

Creating a Model





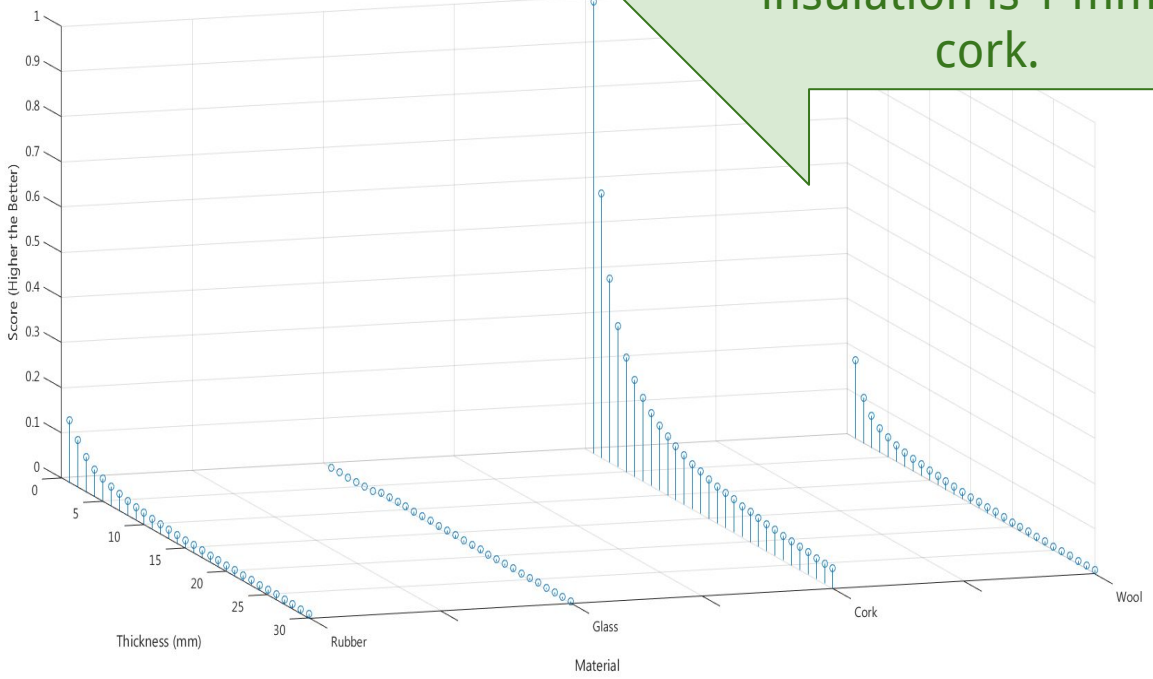
$$Q_{cond} = \frac{kA\Delta T}{d}$$

$$Q_{rad} = \pi r_{shell}^2 * \frac{k_i}{m^2} * sin(\theta)$$

$$\frac{dE_{pot}}{dt} = Q_{rad} - Q_{cond_{p,a}}$$

$$\frac{dE_{air}}{dt} = Q_{cond_{p,a}} - Q_{cond_{a,c}}$$

Material Evaluation



The most effective insulation is 1 mm of cork.

Total (estimated) Price of Insulation: $51.84

Time it takes to reach boiling point: 29 minutes

Material	Thermal Conductivity (W/mK)	Density (Kg/m^3)	Cost ($/Kg)
Rubber	0.13	1100	1.33
Glass	1.05	2600	13.55
Cork	0.07	225	1.93
Wool	0.07	1300	10